REMARKS

In the Office Action, the disclosure was objected to for two informalities. The first informality was that on page 22, line 20, the Examiner believed that FIG. 7 should be FIG. 4. Applicant has reviewed this section and believe that there is no error and that the reference to FIG. 7 is correct.

The second informality was that the reference to another patent application at page 24, lines 28-29 did not include the serial number of that application. With the present amendment, the paragraph containing that reference has been amended to include the serial number of the application.

Independent claims 1, 10, 11 and 17 were rejected under 35 U.S.C §102(b) as being anticipated by Trompf (U.S. Patent No. 5,583,968).

Trompf provides method for training a neural network to perform noise reduction on a noisy speech signal. Under Trompf, clean speech is combined with speech-free noise to form a noisy speech signal. The noisy speech signal is converted into noisy speech vectors, which are provided to the neural network. Using the noisy speech vectors as input, the neural network attempts to remove the noise and thereby produce noise-reduced vectors. To measure the performance of the neural network, clean speech vectors formed from the clean speech signal are subtracted from the noise-reduced vectors to produce an error term. This error term is fed back to the neural network, which uses the error term to adjust the network and improve the noise removal process.

Once the neural network has been trained in this manner, the resulting clean speech provided by the neural network is sent to a speech recognition system to perform speech recognition on the noise-reduced vectors.

Independent claim 1 provides a method of generating an acoustic model in a pattern recognition model. Under the method, additive noises are introduced into a training signal, where the

additive noise is similar to noise that is anticipated to be present in a test signal during pattern recognition. At least one noise reduction technique is applied to the training signal to produce pseudo-clean training data. An acoustic model of the pattern recognition model is then constructed based on the pseudo-clean training data.

Trompf does not show or suggest the invention of claim 1. In particular, Trompf does not show a step of constructing an acoustic model of a pattern recognition model based on pseudo-clean training data. Instead, Trompf uses the noise-reduced feature vectors to train the noise-reduction neural network. It does not use the noise-reduced feature vectors to train an acoustic model.

Note that Trompf is attempting to solve a different problem from the present invention. Under Trompf, the performance of the noise-reduction unit itself is being evaluated during training. As such, it would be natural to add noise to a clean speech signal and then see if the noise reduction unit can remove all of the added noise and reproduce the clean signal.

This is substantially different from the training of acoustic models, where the goal is to associate certain sounds with units of speech. Adding noise to a signal and then removing the noise before training an acoustic model is not intuitive. Under the prior art, either a totally clean speech signal was used to train the acoustic model, in which case, noise would never be added to the clean speech signal, or a noisy training signal was used, in which case, a noise reduction step would not be performed. Performing both the noise addition and noise reduction steps appears to be a counter productive way to form training data for training an acoustic model.

However, the present inventors have discovered that because of slight imperfections in the noise reduction step, adding noise and then removing noise actually provides better

training data for training an acoustic model. There is no suggestion in the prior art, especially Trompf, that this would be true.

Since Trompf does not address the problem solved by claim 1, it does not show or suggest the invention of claim 1 and in particular does not show or suggest a step of constructing an acoustic model based on pseudo-clean training data, in which the pseudo clean training data is formed by adding noise to a training signal and then removing the noise. Since claim 10 depends from claim 1, claim 10 is also not shown or suggested by Trompf.

Independent claim 11 is directed to a pattern recognition model having acoustic model parameters consistent with a model that has been trained through a process that includes identifying a type of noise that is expected to be present in a test signal from which a pattern is to be recognized. A training signal is generated such that the training signal contains the identified type of noise and the noise in the training signal is then reduced to produce training data. Acoustic model parameters are then generated based on the training data.

As noted above for claim 1, Trompf does not generate acoustic model parameters based on training data that is formed by inserting then removing noise. Instead, Trompf only trains a neural network to remove noise from the signal. It makes no mention of training an acoustic model using noise-reduced training data. As such, Trompf does not show or suggest the invention of claim 11.

Independent claim 17 provides a pattern recognition system for recognizing patterns in a test signal. The pattern recognition system includes a pattern recognition model that has model parameters that are formed through a process of generating a training signal such that the training signal includes a type

of noise that is anticipated to be present in a test signal and reducing the noise in the training signal using a noise reduction technique to produce cleaned training values. The cleaned training values are then used to form the model parameters. A noise reduction module in the pattern recognition system receives a test signal and applies the noise reduction technique to the test signal to produce cleaned test values. A decoder receives features of the cleaned test values and accesses the pattern recognition model to identify patterns in the test signal based on the clean test values.

The invention of claim 17 is not shown or suggested in Trompf, because Trompf does not show a decoder that receives cleaned test values and accesses a pattern recognition model that was trained using cleaned training values. Trompf makes no mention of training a decoder, but only discusses a neural network used to remove noise. There is no mention in Trompf of applying cleaned test values to identify a pattern by accessing a pattern recognition model that was trained by removing noise from a training signal. As such, Trompf does not show or suggest the invention of claim 17.

Claims 2-9, 12-16 and 18-29 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Trompf in view of Sameti et al. ("HMM-Based Strategies for Enhancement of Speech Signals Embedded in Nonstationary Noise" herein after Sameti).

Sameti describes an HMM-based strategy for enhancing speech signals. In the method, mixture components are constructed for various types of noise. When a test signal is provided, the noise in the signal is determined and then the mixture models associated with that type of noise are selected. Those mixture models are then used in an enhancement scheme, which can be one of MAP enhancement, AMAP enhancement, or MMSE enhancement. Sameti does not disclose using a noise reduction technique to remove noise from training data and then using the

noise-reduced training data to train an acoustic model of a pattern recognition model.

Since Sameti does not show using noise-reduced training data to train an acoustic model, its combination with Trompf does not show or suggest the invention of claims 1 and 11, or claims 2-10, and 12-16, which depend therefrom.

In addition, Sameti does not show or suggest removing noise from a test signal to form a cleaned test signal and then applying the cleaned test signal to a pattern recognition model that has been trained using cleaned training data. As such, the combination of Sameti and Trompf does not show or suggest this limitation of claim 17. Therefore, claim 17 and claims 18-29 are patentable over the combination of Sameti and Trompf.

With regards to claim 6, Sameti does not show or suggest applying a noise reduction technique that was applied to a set of noisy training data to a test signal to produce pseudo-clean test data. Sameti does not distinguish between a set of training data and a set of test data.

With regard to claim 7, Sameti does not show creating at least two sets of pseudo-clean test data from a test signal by applying at least two different noise reduction techniques to the test signal. Further Sameti does not show applying each set of pseudo-clean test data to a pattern recognition model to identify a pattern in the test signal.

With regards to claim 8, Sameti does not show producing at least two sets of pseudo-clean training data and constructing a separate pattern recognition model for each set of pseudo clean training data.

With regards to claim 9, Sameti does not show or suggest applying each set of pseudo-clean test data to a separate pattern recognition model to identify a separate probability and then selecting a probability from the separate probabilities to identify a pattern in a test signal.

With regards to claims 22-29, neither Trompf nor Sameti show or suggest forming a second pattern recognition model by generating second training signals that include a second type of noise and reducing the noise in the second training signals to produce clean training values.

Sameti does not show forming a second pattern recognition model because Sameti does not show or suggest training a pattern recognition model but instead only discusses the formation of an enhancement model that removes noise from speech. Although Sameti does briefly describe the difference between HMMs used for speech recognition and HMMs used for enhancement, it makes no mention of using its enhancement system to train a speech recognition system. It only mentions the HMMs for speech recognition to distinguish those HMMs from the HMMs it uses in enhancement. Because of this, Sameti and Trompf do not show or suggest the invention of claims 22-29.

In light of the above remarks, claims 1-29 are in form for allowance. Reconsideration and allowance of the claims is respectfully requested.

The Director is authorized to charge any fee deficiency required by this paper or credit any overpayment to Deposit Account No. 23-1123.

Respectfully submitted,

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